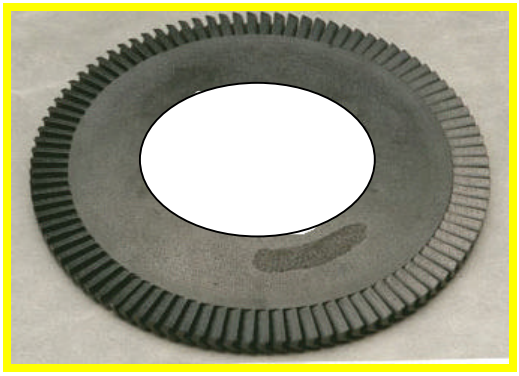
Analysis of Strength and Microstructural Deterioration During Hot Hydrogen-Rich Steam, High Pressure Testing of C/SiC and SiC/SiC Ceramic Matrix Composites



Objective

This effort will quantitatively establish effects of actual turbopump turbine blade environments and stress conditions on selected ceramic matrix, fiber-reinforced composites, and to develop the necessary techniques for measurement, observation and understanding of such effects. Facilities will be established for testing Ceramic Matrix Composites (CMC) in hydrogen-rich steam at elevated pressures up to 1800° F at MSFC. This will become a unique facility having a broad range of capabilities for exposure of CMCs to steam/hydrogen/stress environments at high pressures and temperatures. While silicon carbide and carbon fibers have excellent strength and elastic modulus values, they are susceptible to oxidation. The effects of hydrogen-rich steam and gas pressure have not been studied. Steam effects on CMCs, when present in air or inert atmospheres, have been identified as life limiting. Since many propulsion components are exposed to steam, it is essential to quantify the effect of hot hydrogen-rich steam on the behavior of the most promising CMCs being considered for those components. Samples of various CMCs will be exposed to a variety of conditions, resembling component environments and stresses, and then tested for residual strength, microchemical and microstructural deterioration, as well as failure mechanisms. Advantages of substituting SiC/SiC for C/SiC and advantages of SYLRAMICTM (polymer-derived SiC fibers) over Nicalon™ fibers will be examined.

Why Needed

This effort will provide results that will be essential to future application of any ceramic matrix composite in space transportation systems, particularly for components designed for combustion environments and other components in advanced turbine engine hot-sections. The information obtained from the coupon testing could impact selection of C/SiC or SiC/SiC materials and the type of processing. This would establish or benchmark quantified lifetime determination for CMCs in a representative environment.

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Sponsor

Center Director's Discretionary Fund (CDDF)